CLAIMS

1. A semiconductor light emitting element comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

2. The semiconductor light emitting element according to claim 1 wherein the crystal portion has a wurtzite crystal structure.

3. The semiconductor light emitting element according to claim 1 wherein the crystal portion is made of a nitride III-V compound semiconductor.

4. The semiconductor light emitting element

according to claim 1 wherein the semiconductor layer of the first conduction type, the active layer and the semiconductor layer of the second conduction type are made of nitride III-V compound semiconductors.

5. The semiconductor light emitting element according to claim 2 wherein the crystal planes composing the inclined crystal plane are S-oriented planes.

6. The semiconductor light emitting element according to claim 2 wherein the angles of inclination of the crystal planes composing the inclined crystal plane become stepwise smaller from the bottom of the crystal portion toward the apex thereof.

7. The semiconductor light emitting element according to claim 6 wherein the angle of inclination of the crystal plane including the apex in the plurality of crystal planes composing the inclined crystal plane is in the range from 60 degrees to 65 degrees.

8. The semiconductor light emitting element according to claim 1 wherein the crystal p0ortion is steeple-shaped.

9. The semiconductor light emitting element according to claim 1 wherein the crystal portion has a six-sided steeple configuration.

10. The semiconductor light emitting element according to claim 1 wherein the crystal portion is

elongate in a direction parallel to the major surface.

11. A method of manufacturing a semiconductor light emitting element having: a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having an opening at a predetermined position on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the opening in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

12. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the growth mask is made of one or lamination of silicon nitride, silicon oxide nitride and silicon oxide.

13. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein at least the surface of the growth mask is made of silicon nitride.

14. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the size of the opening in the growth mask is in the range from 2 μm to 13 μm.

15. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the crystal portion has a wurtzite crystal structure.

16. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the crystal portion is made of a nitride III-V compound semiconductor.

17. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the semiconductor layer of the first conduction type, the first semiconductor layer, the second semiconductor

layer, the active layer and the semiconductor layer of the second conduction type are made of nitride III-V compound semiconductors.

18. The method of manufacturing a semiconductor light emitting element according to claim 14 wherein the crystal planes composing the inclined crystal plane are S-oriented planes.

19. The method of manufacturing a semiconductor light emitting element according to claim 15 wherein the angles of inclination of the crystal planes composing the inclined crystal plane become stepwise smaller from the bottom of the crystal portion toward the apex thereof.

20. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the crystal portion is steeple-shaped.

21. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the crystal portion has a six-sided steeple configuration.

22. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the crystal portion is elongate in a direction parallel to the major surface.

23. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein growth temperature for the selective growth is controlled in the range from 920°C to 960°C.

24. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein growth rate for the selective growth is controlled to be equal to or higher than 6 μm/h.

25. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein the growth temperature for the active layer and the semiconductor layer of the second conduction type is set lower than the growth temperature for selective growth of the second semiconductor layer.

26. The method of manufacturing a semiconductor light emitting element according to claim 11 wherein after the second semiconductor layer is selectively grown to have a crystal plane substantially parallel to the major surface on the top thereof, an undoped semiconductor layer is grown on the top of the second semiconductor layer.

27. The method of manufacturing a semiconductor light emitting element according to claim 11 further comprising:

a step of removing the growth mask between the step of selectively growing the second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the opening in the growth mask and the step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type.

28. An integrated semiconductor light emitting device including a plurality of integrated semiconductor light emitting elements each comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

29. A method of manufacturing an integrated semiconductor light emitting device integrating a plurality of integrated light emitting elements each having a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to

exhibit a convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having openings at predetermined positions on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the openings in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

30. The method of manufacturing an integrated semiconductor light emitting device according to claim 29 wherein the size of each opening in the growth mask is in the range from 4/1 to 1 time the size of each

semiconductor light emitting element.

31. The method of manufacturing an integrated semiconductor light emitting device according to claim 29 wherein the distance between nearest two of the openings is equal to or more than two times the size of each semiconductor light emitting element.

32. The method of manufacturing an integrated semiconductor light emitting device according to claim 29 wherein the size of each opening in the growth mask is in the range from 2 μm to 13 μm.

33. The method of manufacturing an integrated semiconductor light emitting device according to claim 29 wherein the distance between nearest two of the openings is equal to or more than 10 μm.

34. An image display device including a plurality of semiconductor light emitting elements each comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the

semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

35. A method of manufacturing an image display device integrating a plurality of integrated light emitting elements each having a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having openings at predetermined positions on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the openings in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

36. An illuminating device having a single semiconductor light emitting element or a plurality of integrated semiconductor light emitting elements each comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor

layer of the second conduction type.

37. A method of manufacturing an illuminating device having a single semiconductor light emitting element or a plurality of integrated semiconductor light emitting elements each including: a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane composed of a plurality of crystal planes inclined from the major surface by different angles of inclination to exhibit a convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having an opening at a predetermined position on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the

first semiconductor layer exposed through the opening in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

38. A semiconductor light emitting element comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

39. A method of manufacturing a semiconductor light emitting element having: a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially

convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having an opening at a predetermined position on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the opening in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

40. An integrated semiconductor light emitting device including a plurality of integrated semiconductor light emitting elements each comprising:

a semiconductor layer of a first conduction type

which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

41. A method of manufacturing an integrated semiconductor light emitting device including a plurality of integrated semiconductor light emitting elements each having: a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second

conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having openings at predetermined positions on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the openings in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

42. An image display device including a plurality of semiconductor light emitting elements each comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the

semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

43. A method of manufacturing an image display device integrating a plurality of integrated light emitting elements each having a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having openings at predetermined positions on the first semiconductor layer;

a step of selectively growing a second

semiconductor layer of the first conduction type on the first semiconductor layer exposed through the openings in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor layer.

44. An illuminating device having a single semiconductor light emitting element or a plurality of integrated semiconductor light emitting elements each comprising:

a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole;

at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion;

a first electrode electrically connected to the semiconductor layer of the first conduction type; and

a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type.

45. A method of manufacturing an illuminating device having a single semiconductor light emitting element or

a plurality of integrated semiconductor light emitting elements each including: a semiconductor layer of a first conduction type which is formed on a major surface and includes a convex crystal portion having an inclined crystal plane exhibiting a substantially convex plane as a whole; at least an active layer and a semiconductor layer of a second conduction type which are sequentially layered at least on the inclined crystal plane of the crystal portion; a first electrode electrically connected to the semiconductor layer of the first conduction type; and a second electrode formed on the semiconductor layer of the second conduction type on the crystal portion and electrically connected to the semiconductor layer of the second conduction type, comprising:

a step of growing a first semiconductor layer of the first conduction type on a substrate;

a step of forming a growth mask having an opening at a predetermined position on the first semiconductor layer;

a step of selectively growing a second semiconductor layer of the first conduction type on the first semiconductor layer exposed through the opening in the growth mask; and

a step of sequentially growing at least the active layer and the semiconductor layer of the second conduction type to cover the second semiconductor

layer.